Theme 1: Forage production and pasture management

GROWING FODDER TREES AND USE AS FEED (Level 3)

Topic	Training & information Content
1.1	Planning of fodder/feed requirements for the dry season
1.2.1	Integrated soil fertility management I
1.2.2	Integrated soil fertility management II
1.3	Use of natural resources, compost making, farmyard manure, manure storage and use
1.4	Growing maize and sorghum for fodder and estimating time of harvest and yield
1.5	Brachiaria, Panicum, & Napier (cut and carry) grass management
1.6	Growing fodder trees and use of feed
1.7	Estimating of dry matter content, feeding value and yield of various fodder crops
1.8	Guidelines for Tropical pasture management and grazing management
1.9	Scaled mechanization of forage production and harvesting (harvesting practices)
1.10	Operating farm equipment and self-propelled tractors
1.11	Mechanization of feeding management
1.12	Economics of forage and pasture production

1. You will learn about (learning objectives):

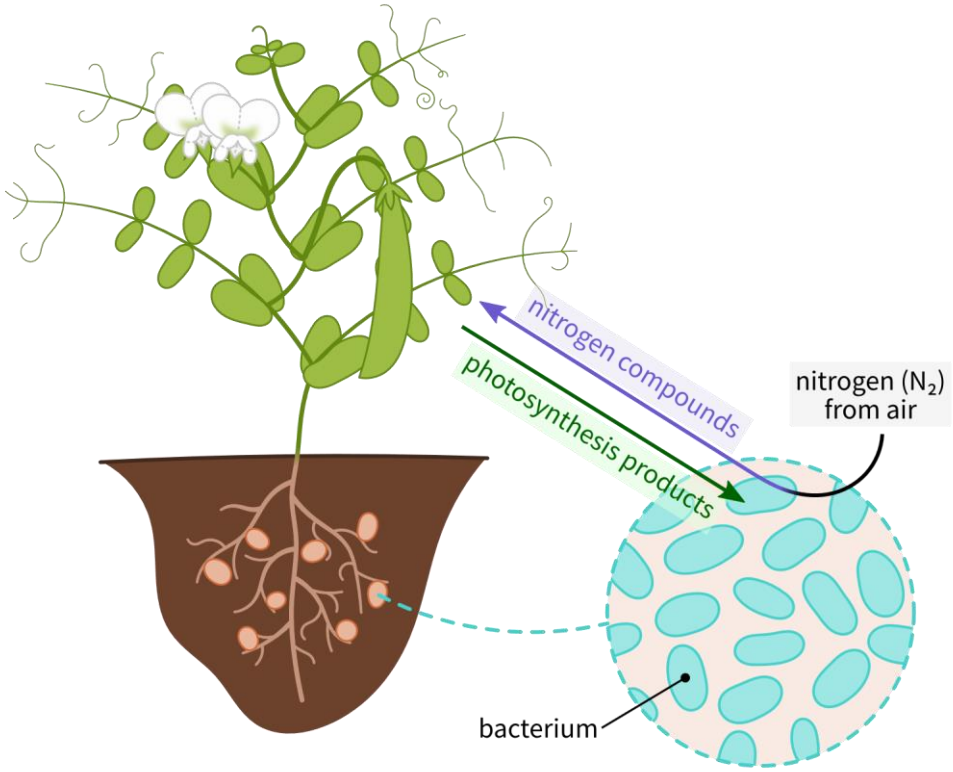
- ❑ Importance of fodder trees in farming systems
- ❑ Significance of fodder trees as a supplementary feed to the diet

Desmanthus pernambucanus

2. Benefits of (agro)fodder trees

The roles of (agro)fodder/multipurpose trees include:

- Fodder trees are a high quality supplement to animal diets especially during dry seasons. The leaves area source of protein for pigs, ducks etc
- Have multipurpose use in households e.g. source of food to cattle and households e.g. pigeon peas
- Assist in controlling soil erosion when used to form contours or in alley cropping systems
- Leguminous fodder trees improve fertility of soil through nitrogen fixation/free-living associations with the root layer
- Storage medium for CO^2 (the standing biomass)
- Storage for CH_4 (the decaying organic matter from fallen leaves and unused branches)
- Are extra source of income from sale of seedlings
- Act as wind breakers and shelter belts around farms
- Used as a fence for homesteads
- Provide construction materials and firewood
- Encourages farmers to adopt to climate smart farming practices.



3. Characteristics of fodder trees

- Are deep rooted making the plants more tolerant to drought, reducing dependence on rain or water irrigation systems
- Provide feed over short periods upto five times a year under proper management
- Have good nutritive value and adequate palatability to livestock
- Require minimal management and inputs like weeding and fertilizer use
- Good growth (survival) rate when planted
- Have long production life (fodder trees/shrubs) over years (up to 20 years)
- Little to no competition with food crops when grown together
- Have the ability to produce seeds and some are viable for vegetative propagation.

Tree Lucerne (*Chamaecytisus proliferus*)

4. Examples of fodder shrubs and trees

- Calliandra (*Calliandra calothyrsus*)
- Leucaena (*Leucaena leucocephala)*
- Sesbania (*Sesbania sesban)*
- Gliricidia (*Gliricidia sepium)*
- Pigeon pea (*Cajanus cajan)*
- Moringa (*Moringa aleifera*)
- Mulberry tree *(Morus alba)*
- Tree Lucerne (*Chamaecytisus proliferus*)

Calliandra
(*Calliandra calothyrsus*)

Mulberry tree
(Morus alba)

Gliricidia
(*Gliricidia sepium)*

5. Growing fodder trees

Steps in sowing fodder trees (legume trees)

- Land preparation (Refer to module on Growing maize for fodder)
- Seed treatment
- Rhizobium inoculation (only done to legume tree species)
- Establishing fodder trees
    - Sowing seeds in nursery
    - Vegetative propagation
    - Direct field planting

6. Seed treatment

- Most fodder tree seed have a hard seedcoat that prolongs germination by inhibiting water infiltration, hence the reason to break seed dormancy. This can be done through:

    i. Cold water treatment
    ii. Mechanical scarification/Nicking
    iii. Chemical seed coat degradation
    iv. Hot water treatment

6.1 Seed treatment Cont'd…

Cold water treatment

- Method is mostly used on small seeds
- Soak seeds in cool water for 12-48 hours

Mechanical scarification/Nicking

- Seed is scratched off using a file, knife or sand paper
- Care should be taken to avoid damaging the seed embryo by avoiding the micropyle.

6.2 Seed treatment Cont'd…

Chemical seed coat degradation

- Place seeds in a solution of concentrated sulphuric acid and stir according to the species' recommended time period
- Rinse off the acid by rinsing seeds in cold water and dry off the water.

Hot water treatment

- Soak seeds in hot water for 2-5 minutes then cold water for 12 hours
- Care should be taken not to kill the seed.

Seeds

Seeds immersed in hot water

6.3 Seed treatment of various fodder trees

- Different species of seed are treated differently as shown below;

Treatment conditions for fodder trees					
Fodder tree species	**No treatment**	**Cold water**	**Mechanical scarification**	**Hot water use**	**Acid use**
Calliandra (*Calliandra calothyrus*)	N/A	Yes	Yes	Yes	N/A
Leucaena (*Leucaena spp.*)	N/A	N/A	Yes	Yes	Yes (5-15mins)
Gliricidia (*Gliricidia sepium*)	Yes	Yes	Yes	N/A	N/A
Pigeon pea (*Cajanus cajan*)	Yes	Yes	N/A	N/A	N/A
Sesbania (*Sesbania sesban*)	N/A	Yes	Yes	Yes	N/A

7. Rhizobium inoculation

- Inoculation increases legume nodulation for the process of nitrogen fixation where atmospheric nitrogen in air is converted into ammonia for use by the plant
- The process involves treatment of rhizobium inoculum on seed before sowing or after seed treatment
- The seed has to be planted immediately after inoculation when the bacteria is still alive.
- Seedlings can be inoculated after germination by mixing inoculum with cool water and irrigating the seedlings.
- 50kgs of inoculum can inoculate 10,000 seedlings
- It is important to identify the right inoculum for each tree species.

7.1 Steps of inoculating seeds with rhizobium bacteria

1. Mix the inoculant with sticking agent e.g. molasses, both at required amounts
2. 200 grams of inoculum can form 60 litres of solution that can be used on 500 grams of seeds
3. Stir the mixture evenly to form a slurry-like solution
4. Add required amount of seeds to the solution
5. More sticking agent can be added at this point if required
6. Mix until a sticky coating is formed on the seeds
7. Dry the seeds by spreading in a cool shade.

8. Establishing fodder trees

- This can be done through the following:

    i. Sowing fodder tree seeds in a nursery
    ii. Vegetative propagation
    iii. Direct field planting

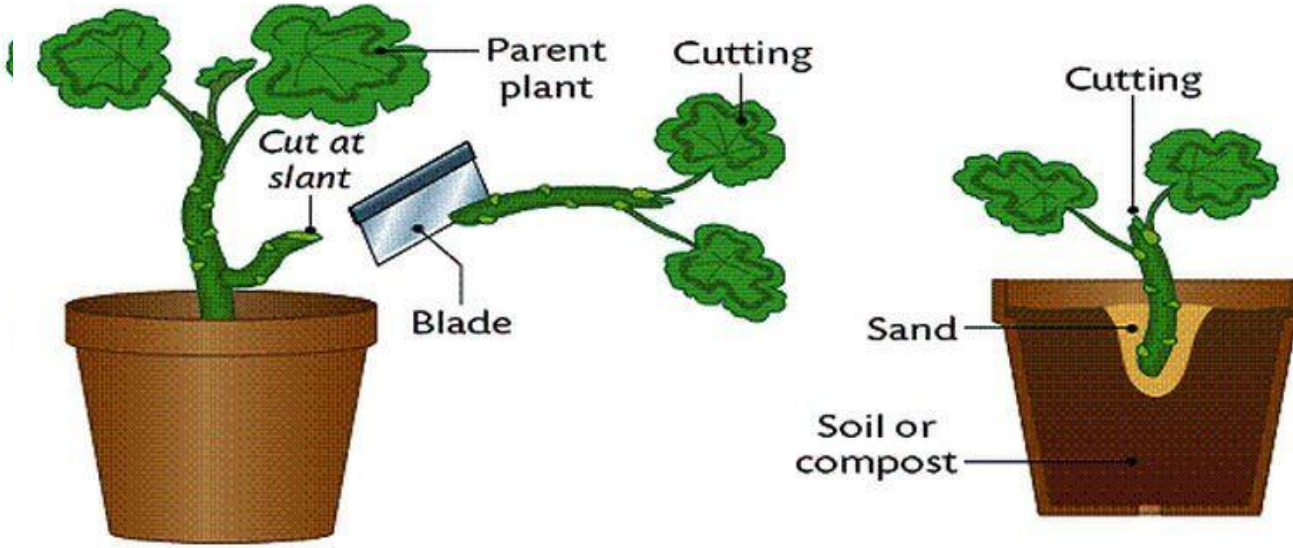
Moringa aleifera

8.1 Sowing fodder tree seeds in a nursery

- Nursery stands are easily made by four wooden poles and at the top shaded with small sticks or old hay grass or stovers.
- Nursery should be shaded, cool, aerated and allow light penetration.
- Seeds should be sown at 2-3 times the seed width (i.e. between two rows/lines), but if in area receiving low rainfall, should be sown at 10 times the seed width.
- Attacks by weeds, insects and pests should be managed.

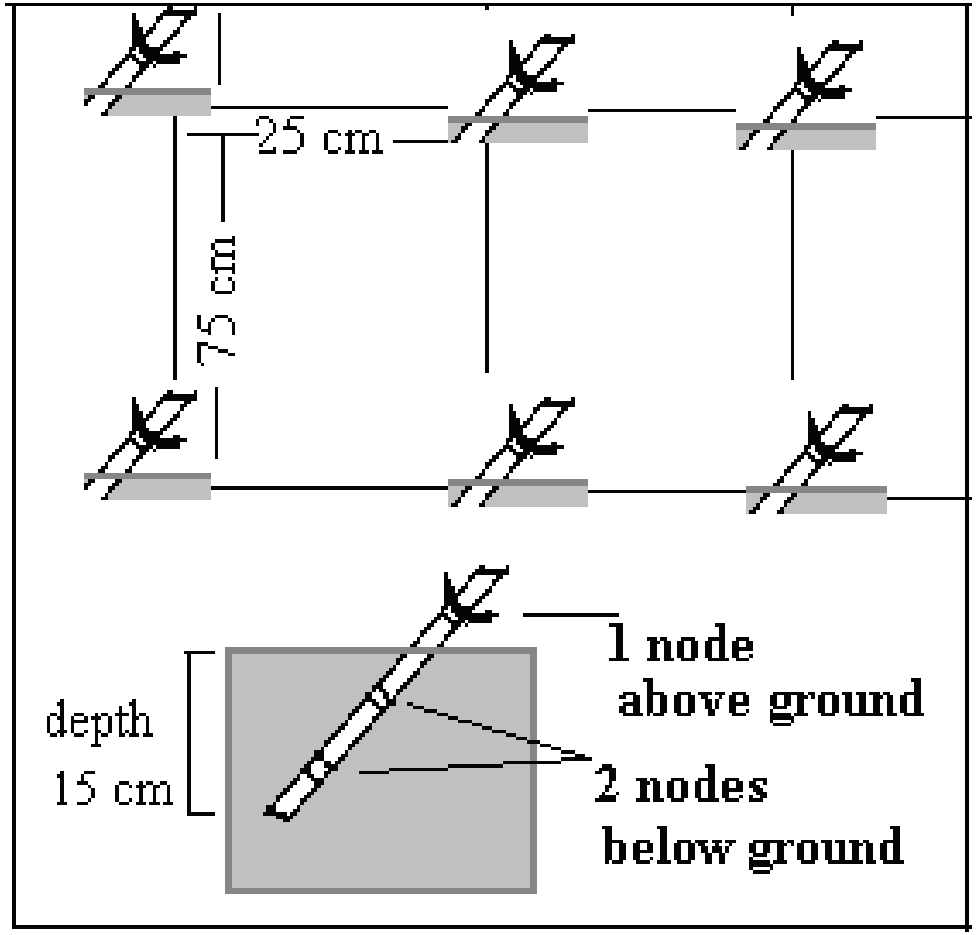
8.2 Vegetative propagation of fodder trees

- Cuttings should be healthy and straight (stems, roots, branches or coppice growths)
- Cutting equipment should be sharp and clean/sterilized
- Vegetative parts should be harvested in the beginning of rains or during dry periods
- Vegetative materials should be stored in a cool, dry and shaded place.



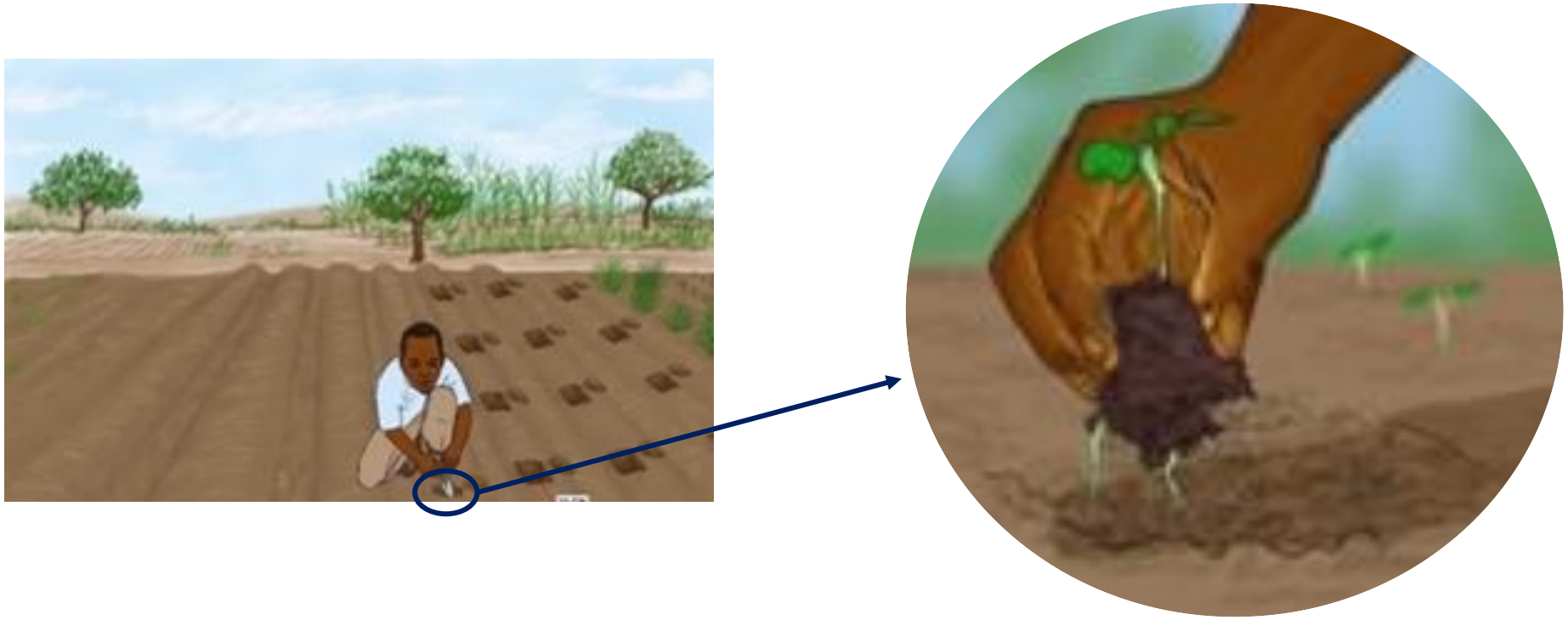
8.3 Vegetative propagation of fodder trees Cont'd…

- Cuttings should be placed at an angle of 45 degrees.
- Vegetative materials should be planted and not shoved in the ground, for proper root development.
- Cut off the tip in case of water accumulation at the tip to avoid stem rot.
- Rooting can be promoted by scarring the lower part and even more when a rooting hormone is applied to the scarred area.



8.4 Direct field planting of fodder trees

- Land should be well prepared before seeds are planted in the field
- Larger seeds (i.e. Sesbania) do not require seed treatment and can planted directly in the fields
- Seedlings from the nursery and vegetative materials are also transferred to the field
- Seedlings in the nursery can be transplanted after 6-16 weeks.



8.5 Direct field planting of fodder trees Cont'd…

- Before planting, the seedlings should be hardened in direct sunlight 1 week prior
- Vegetative propagules can be transplanted to the field after 2-3 weeks.

9. Fodder trees as animal diet supplements

- Fodder tree leaves can be used as supplements in diets of dairy cows especially during dry season. They are used to mostly supplement dairy meal or other protein rich forages
- Different fodder tree leaves can be used as a supplement feed i.e. 3kg of calliandra can replace 1kg of dairy meal
- Caution should be taken on total percentage the supplement accounts for in total diet. This is due to presence of antinutritive factors of trees e.g., Mimosine contained in Leucaena. This can be done by considering;
    - the weight of the animal
    - the recommended amount of a particular fodder tree a dairy cow can consume per day

Leucaena

10. Management of fodder trees

- Maintain good soil fertility e.g. through fertilization to achieve good production of fodder tree foliage.
- Timing of pruning (harvesting) affects quantity of fodder produced.
- Do not cut trees at a height that is too low close to the ground as regrowth will be slower.
- Extreme climatic conditions affects fodder growth.

11. **Calliandra** (*Calliandra calothyrsus*)

- Calliandra is one of the most commonly cultivated leguminous fodder tree in Uganda and with its multipurpose use it is also incorporated in agroforestry systems
- It can be established from seeds or stem cuttings
- Seeds are planted in nurseries and later transplanted in the farm.
- For easier germination, scarification is required
- Calliandra does well in a wide range of soils including sandy to volcanic soils that are acidic
- It also grows well in areas receiving rainfall between 700 to 3000mm per year; but also tolerant to dry spells.

11.1 Feeding calliandra

- First cut can be done 8-12 months after planting, recommended cutting height is 1m above the ground
- It is advisable to harvest between 2 to 4 months to obtain higher nutritive value and biomass
- Prunning can be carried out 4-5 times a year
- Calliandra is a good source of crude protein (20 to 28%)
- It is recommended to feed calliandra fresh to maximize its forage quality.
- Drying calliandra forage for feeding is discouraged as it has negative impacts on the quality of forage.

11.2 Feeding calliandra Cont'd…

- Feeding diets rich in calliandra results in lower methane emissions as a result of its high fiber digestibility, compared to feeding grasses or herbaceous legumes
- It's yields ranges around 7-20 tonnes per hectare per year, depending on soil and environmental conditions
- Dairy cows can take between 5-10 kgs of fresh calliandra per day depending on productivity. Maximum is not to feed more than 10 kgs of fresh calliandra per day
- Farmers may need 500 trees to feed a cow throughout the year at the rate of 6 kgs of fresh calliandra per day. This is equal to 2kg dry matter per day (0.4-0.56 kg crude protein per day).

12. Leucaena (*Leucaena leucocephala)*

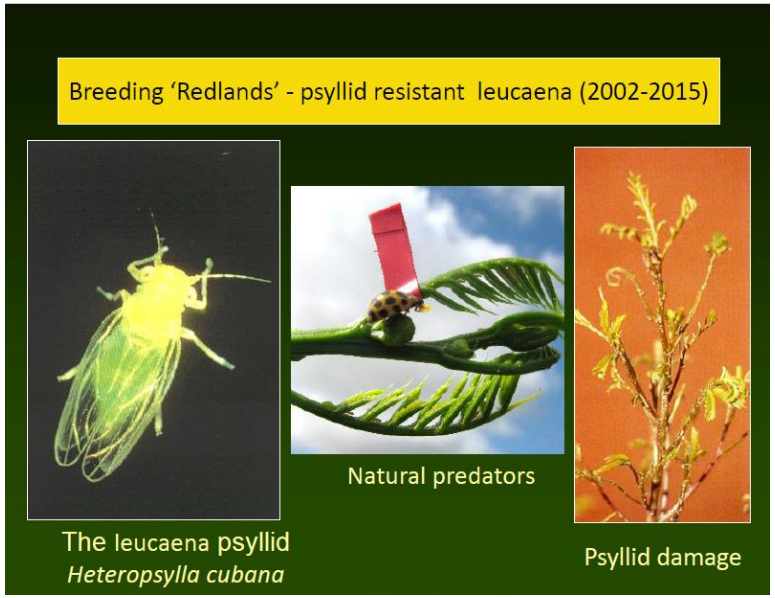
- Leucaena is a leguminous, multipurpose tree that provides fuel wood, green manure, improves degraded lands and can be used as a cover crop
- It is resistant to drought and a good feed source for cattle
- The leaves contain about 22.7% crude protein and survive well on degraded soils which are low in nutrients.
- Does best in well drained soils, does not like soils that retain too much water. It grows preferably in neutral to alkaline soils.
- Grows in area receiving between 650 – 3000 mm of rainfall per year.
- Leucaena can be grown directly to the field or in nurseries.
- Seeds may need to be treated; sowing rate per hectare is 1-2kgs.

12.1 Feeding leucaena

- Grazing intervals can be 6 to 8 weeks or 12 weeks during unfavourable conditions (dry periods).
- First grazing can be done when plant is 1.5 m high, after proper root establishment.
- Harvesting after re-growth can be done when the plant attains a height of 50-60cm. Pruning at times is beneficial for regrowth.
- Leucaena should be lightly grazed in the first year and grazing management done over other years.

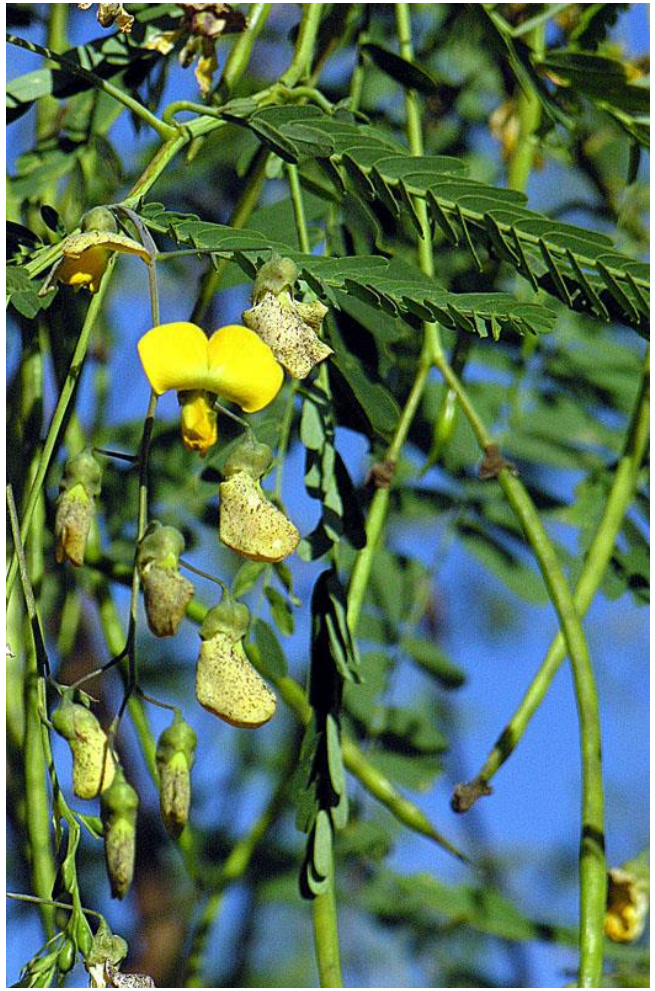
12.2 Feeding Leucaena Cont'd…

- Livestock cannot consume more than 30% of Leucaena forage in their diets on dry matter basis per day as it may be toxic due to mimosine contained in the plant
- Feeding livestock with Leucaena can increase live-weight gain and improve milk production.
- Feed two hours before milking due to its effect of tainting milk.
- It's nutritional value can be comparable to alfalfa
- Leucaena can produce up to 3-30 tonnes dry matter per hectare per year, depending on soil and environmental conditions.



13. Sesbania (*Sesbania sesban, S. grandiflora*)

- Sesbania grows best in areas receiving rainfall between 500-2000 mm per year
- The plant grows in wide variety of soils and can tolerate soils that are acidic, alkaline, saline and with low phosphorus levels
- Sesbania withstands waterlogging in the late stages of seed growth only
- It can be intercropped with variety of cereal crops and grasses in various farming systems
- *Sesbania grandiflora* is a valued fodder for ruminants. It is used in grazed paddocks as mature trees are out of browse height, or as cut-and-carry forage integrated into cropping systems. Its low tolerance to defoliation makes it poorly suited to direct grazing



Sesbania sesban

13.1 Feeding sesbania

- Sesbania can be harvested (cut and carry) at 1-2 m high.
- it can undergo 3-5 cuts a year
- Sesbania leaves protein content is above 22% in the dry matter (DM)
- DM digestibility of Sesbania species is greater than that of other tree legumes.
- It yields between 4-20 tonnes dry matter per hectare per year.
- As a supplementary feed sesbania can be included up to 25% of the diet.

Sesbania sesban

14. Gliricidia *(Gliricidia sepium)*

- Gliricidia has been identified as an excellent quality forage in many tropical countries due to its' nutritive value and composition.
- It has a high content of crude protein (20- 25%) that readily digests in the rumen
- The plant grows well in areas receiving rainfall between 900-1,500mm per year
- It is tolerant to waterlogging and wide range of poorly fertile soils (poor growing conditions)
- It is not greatly affected by pests attacks.
- Gliricidia is a leguminous fodder trees whose leaves have a half life of 20years making it a good litter and soil improver.
- It exhibits fast growth and has deep rooting system making it a good windbreaker.

Gliricidia sepium

14.1 Feeding Gliricidia

- Harvesting the tree from vegetative cutting can be done after 7 months
- Harvesting tree from seedling can be done after 14 months
- Interval cuttings/pruning can be done after 2-3 months in rainy seasons
- It is recommended to harvest the tree at a height of 1-2 m height
- Gliricidia is considered to increase dry matter intake and body weight in heifers and steers
- Wilt leaves for 24 hours after harvesting to reduce odour of the leaves
- It yields about 9-16 tonnes per hectare of DM.
- It is recommended to feed 1-3% of the cows body weight (3-12 kgs/day fresh to a 400 kg cattle).

Gliricidia in hedgerows with *Urochloa decumbens* cv Basilisk

15. Pigeon pea (*Cajanus cajan)*

- Pigeon pea is a multipurpose legume crop; pods are food for human consumption and leaves are feed to livestock.
- It is a drought-resistant crop and can grow in areas with less than 650mm of rainfall
- Does well in areas receiving rainfall above 625 mm per year
- It is a perennial crop that can be re-planted after 2-3 years
- Suited to wide range of soils, with a pH of 5-7
- It can be established by direct seeding (seeds do not require treatment before sowing)
- Sow seeds to a depth of 2-4cm, at the rate of 20-25kgs/ha
- Insufficient rain in the first 2 months may cause poor establishment, hence demanding irrigation for the period
- Pigeon pea can be intercropped with cereals.

15.1 Feeding pigeon pea

- Grazing should be done at full establishment of the crop
- Pigeon pea does not withstand continuous grazing thereby necessitating rotational grazing practices
- Maintain light grazing due to the crop’s sensitivity to defoliation
- Pigeon pea is rich in protein but has low digestibility due to its high fibre content
- Fresh pigeon pea leaves and hay have dry matter content of 50-60%.
- Yield is from 20-40 tonnes dry matter per hectare per year.

16. Uses of fodder trees by livestock

- Fodder trees are a cheap source of feed to livestock compared to concentrates
- Leguminous fodder trees offer feed rich in high protein to livestock, they contain between 14 - 35% protein content
- Source of minerals such as calcium, sulphur, copper and iron
- Fodder trees can be conserved as hay for feeding during shortage seasons hence improved feed security
- Fodder trees can offer medicinal value to livestock by managing parasites
- Shade from fodder trees offer comfort to livestock by reducing heat stress during grazing

Note: *Most fodder trees are harvested through pruning (cut and carry) or grazed directly.*

Source:
https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.flickr.com%2Fphotos%2Fplant-trees%2F4850328120&psig=AOvVaw1U2C8Z4g5t4l8vMNbd8Eky&ust=1625335438711000&source=images&cd=vfe&ved=0CAoQjRxqFwoTCODi9cX8xPECFQAAAAAdAAAAABAD

17. Fodder trees in farming systems

- Fodder trees can be incorporated in various ways in agroforestry systems as follows;
  - Vegetation on uncropped land areas
  - Areas of land that cannot be used for cropping like boundaries of farms & forests
  - Planting fodder trees to act as a hedge/living fence around the farm
  - Inter-cropping fodder trees with other crops
  - Fodder trees can be used to create contours and terraces along hills for best soil management practices.

18. Fodder trees in agroforestry systems

- Trees in agroforestry systems can be incorporated with crops, pasture and animals as in the systems below;

i. Silvipastoral systems

- Is the incorporation of trees and pasture/animals. Grasses or legumes are grown in the inter-space of trees.
- This method improves fodder productivity; and is mostly practised in the arid and semi-arid areas

ii. Agrosilvocultural systems

- Is the combination of crops and trees similar to alley cropping systems

iii. Agrosilvipastoral systems

- Involves trees, crops and pastures/animals

19. Fodder tree adaptation challenges

- There exists poor skills and knowledge on nursery establishment, pruning and seed collection of fodder tree species
- There are inadequate fodder tree species suited to different agro-ecological zones
- There is a poor seed supply system, poor seed collection practices for fodder trees among farmers hence reducing adoption by farmers
- General lack of emphasis on the multipurpose benefits of fodder trees and their contribution to climate smart agriculture.

20. Possibilities of fodder tree up-scaling

- Studies on the contribution of high quality forage consumption in reduction of methane produced per kilogram of meat and milk produced, and the contribution of trees in reduction of carbon foot print necessitate upscaling through;
  - Improving research as relates to multi-purpose agroforestry trees in livestock systems
  - Development and adoption of agroforestry practices within farming systems
  - Improving access of inputs and services (i.e. seeds and extension services)
  - Improve linkages between actors by involving stakeholders
  - Review and consolidation of policies that run across different fields i.e. forestry, agriculture and environment.

Useful link: https://www.tropicalforages.info/text/intro/index.html

21. Take home summary

- The characteristics of fodder/multipurpose trees sought by farmers relate to the need to minimize inputs and maximise outputs. They tress require:

    - Availability of different species
    - Ease of establishment and management
    - Resistance to pests and diseases
    - Ease of harvesting
    - High yield (biomass)
    - Achieve higher animal productivity with minimal inputs

Moringa oleifera tree, tree leaves, and leaves powder.

Further reading: Mahfuz S, Piao XS. Application of Moringa (Moringa oleifera) as Natural Feed Supplement in Poultry Diets. Animals. 2019; 9(7):431. https://doi.org/10.3390/ani9070431

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